Instrument Incubator

Tunable Light-guide Image Processing Snapshot Spectrometer (TuLIPSS) for Earth Science Research and Observation

Completed Technology Project (2017 - 2019)

Project Introduction

Objectives and Benefits We propose to develop and test a Tunable Light-guide Image Processing Snapshot Spectrometer (TuLIPSS) for future implementation on UAV, airborne, and orbiting platforms. The proposed system, when fully operational, will be able to perform a wide variety of Earth remote sensing observations. Here we focus on the development of a high fidelity functional prototype to be flight-tested on an aerial platform by the end of the funded period. TuLIPSS will be capable of acquiring instantaneous images across the visible and near-IR, with a flexible spatial/spectral resolution tradespace. This is accomplished using custom-adaptable fiber optic image processing bundles whose input is in the form of a densely-packed coherent waveguide. The optical output from each waveguide, or line of waveguides, can be flexibly designated as spatial or spectral enabling a wide variety of observational configurations.. Thus, the system's innovative aspect is the controlled repositioning of pixels between the input and output of waveguide coherent structures, allowing efficient multi-dimensional (x, y, λ) snapshot imaging and operational flexibility. This flexibility enables a range of spatial/spectral configurations (e.g. specific sub-bands around target lines, prioritization of spatial or spectral resolution, etc.) to satisfy specific observational goals. Additionally, TuLIPSS is low resource (mass, volume, power) but highly capable. The ability to collect data across an entire scene in a single exposure makes TuLIPSS uniquely suited to a range of Earth science applications, including the ability to record transient surface and atmospheric phenomena, and to provide multiple views through an atmospheric column for tomographic studies. As proposed, TuLIPSS will allow: a) snapshot hyperspectral image acquisition and high light collection efficiency b) tunable adjustment of spatial and spectral resolution, and flexible selection of target wavelengths c) spectral coverage across relevant wavelengths from 400nm – 1000nm d) easy exchange of image sensors, allowing different camera formats and sensitivities e) flexibility in development of the number of input/output fiber bundles Proposed Work and Methodology The main project objectives include: - Development of high resolution fiber optic bundle components and advancement of fiber bundle technology - Development of an automatic spectral/spatial resolution tuning mechanism - Development of automatic calibration and control routines - System integration for VIS-NIR imaging range - Testing in airborne environment The basic principal of the spatial/spectral image processing methodology proposed here is the coupling of fore optics to a light-guide image processor (LIP) that distributes the incoming photons to a sensor array in a flexible, application-specific manner, describing spatial and spectral information. In this project we will develop a system capable of automatic adjustment of sampling. Three main configurations will include 400x330x30 to 250x210x80 and 150x125x250 cube size where the numbers denote the ranges in the two spatial and one spectral dimensions. The camera used to assemble the system will be PCO Edge 5.5 capable of recording relevant signals in the 400-1000 nm range. TuLIPSS will allow selection of the sub-band at selected spectral-spatial sampling. Note:

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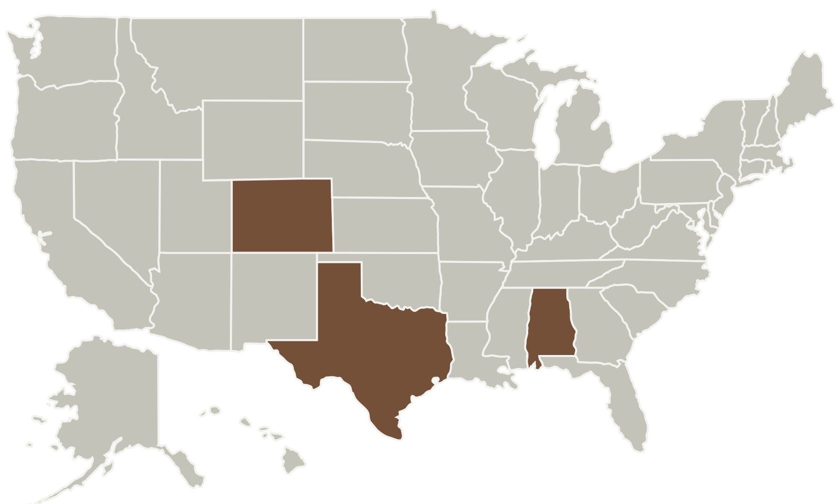
Table of Contents

the spectral range can be expanded by incorporating a second focal plane array sensitive to 1000-1900 nm range. This extension will be considered in subsequent projects. Period of Performance Duration of the project is three years: 1/1/17 – 12/31/19. Entry and Planned exit TRL The proposed system has been developed beyond the breadboard stage and is currently estimated to be at TRL 3. The system is well-matched to reach a level of TRL 5 by the end of the funding period.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Rice University	Lead Organization	Academia	Houston, Texas

Primary U.S. Work Locations	
Alabama	Colorado
Texas	

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Rice University

Responsible Program:

Instrument Incubator

Project Management

Program Director:

Pamela S Millar

Program Manager:

Parminder S Ghuman

Principal Investigator:

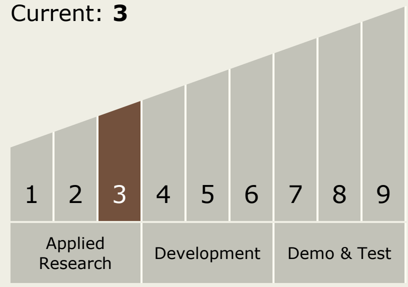
Tomasz S Tkaczyk

Co-Investigators:

Aaron Parvis
David Alexander
Dale A Quattrochi
Scott W Mcintosh
Burgess Howell

Technology Maturity (TRL)

Start: **3**
Current: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.1 Detectors and Focal Planes

Target Destination

Earth